Letter Report on the Review of the Revised BTeV Schedule
June 22, 2004

Introduction

On April 27-29, 2004, a Department of Energy (DOE) Review Committee conducted a review of the B Physics at the Tevatron (BTeV) construction project at Fermi National Accelerator Laboratory (Fermilab). The purpose of this review was to validate the cost range and schedule needed for Critical Decision 1 (CD-1), Approve Alternative Selection and Cost Range.

While the Committee concluded that the technical scope and cost estimate are ready for CD-1, they determined the proposed schedule is not achievable with the proposed funding and resource profile. The Committee recommended that Fermilab develop a schedule and funding profile for BTeV, such that the desired scientific capabilities are obtained while ensuring that the scientific output is competitive and timely. The committee recommended that revised plans be provided to DOE as soon as possible to support the CD-1 decision process.

The purpose of this letter report is to summarize the Committee's findings and observations developed based on a review of the revised schedule submitted to DOE by Fermilab on June 14, 2004.

Methodology

On May 26, 2004, in a formal charge memorandum, Robin Staffin requested Daniel R. Lehman to consult with the original BTeV Review Committee and assess the viability of a revised BTeV schedule. The request contained the two charge questions from the April review related to the schedule.

1. Is the proposed schedule reasonable and appropriate in view of the technical tasks and proposed funding profiles?
2. Has the critical path been identified?

A review strategy was developed and coordinated with the Committee on May 28, 2004. The major review tasks are outlined in Table 1.

Table 1. Schedule Review Tasks

Review Task	Date
Provide revised schedule to the full Review Committee	June 15, 2004
After receiving input from their subcommittee, subcommittee chairs submit their analysis to the entire Committee by email; Make appropriate contacts with BTeV points of contact	June 18, 2004
Conference call by the review committee chairs to discuss the revised schedule and analyses	June 21, 2004
Subcommittee chairs update their analyses and submit final versions	June 22, 2004
DOE drafts report and sends to committee for review and comment	June 23, 2004
Final comments submitted to DOE	June 24, 2004
DOE completes report	June 25, 2004

Key Elements of Revised Schedule

In order to address the Committee's recommendations from the April review, the BTeV schedule has been revised and improved by: (1) a two-phased staged installation schedule adding approximately 6 months to the original plan, (2) developing an improved funding profile, (3) rescheduling of project activities with respect to the critical path, and (4) using a uniform method for determining schedule contingency for all subprojects.

The newly proposed two stage installation will begin with Stage 1 from early August to the end of November 2009. The C0 Interaction Region magnets and a large fraction of the BTeV detector, including the entire pixel detector, the gas-radiator RICH system, and about ½ of the electromagnetic calorimeter will be installed during the Stage 1 installation period. It will be followed by 7 months of operation from December of 2009 until the end of June 2010. In Stage 2, the remaining ½ of the calorimeter, the liquid-radiator RICH system, the final elements of the tracking and Muon system, and the final part of the data acquisition and trigger capacity will be installed. The Stage 2 installation will take place in July, August and September of 2010.

A new summary schedule showing the amount of float in each Level 2 subproject and Tier 1 project milestones from the report are provided in Appendix A. The Fermilab report also included a proposed schedule for DOE Critical Decisions as shown in Table 2.

Table 2. Proposed DOE Critical Decisions

Critical Decision	BTeV Projected Date
CD-0: Approve Mission Need	2nd Quarter FY04 (actual)
CD-1: Approve Alternative Selection and Cost Range	3rd Quarter FY04
CD-2: Approve Performance Baseline	1st Quarter FY05
CD-3a: Approve Limited Construction (long lead procurements)	1st Quarter FY05
CD-3b: Approve Start of Construction	3rd Quarter FY05
CD-4: Approve Start of Operations or Project Closeout	3rd Quarter FY11

Summary of Committee Findings and Observations

During the Committee's conference call to discuss the revised schedule there was general consensus that the BTeV team's creative, substantive and rapid turnaround efforts has resulted in a credible and reasonable revised schedule for meeting the overarching goals of the project. The staged approach and the roughly doubled installation time are significant improvements and have greatly increased schedule float in almost all project activities. The revised funding profile (Appendix B) also has significantly more contingency in each year.

The committee found the proposed schedule for the construction of the detector is reasonable and appropriate in view of the technical tasks and proposed funding profiles.

However a few concerns were identified in the following specific areas:

- Electromagnetic Calorimeter: There is potential for a significant schedule risk on crystal delivery due to overlapping CMS production if the CMS production schedule slips. A possible cost risk exists associated with the assumed engineering and assembly manpower from Russia and China if these resources fail to materialize.
- Commissioning: The time period for commissioning the trigger and associated detector systems allowed by the overall BTeV schedule may not be adequate to ensure efficient operation throughout the first physics run scheduled to occur between Stage 1 and Stage 2. The Committee bases this assessment on the experience of CDF, D0, and BaBar experiments. While the Committee views the operation period between Stage 1 and Stage 2 as having potential for producing a modest amount of physics quality data from the BTeV experiment with a colliding beam, this operating period provides an engineering run to assess overall and subsystem performance.
- Installation: The revised schedule and budget is a significant improvement. However, it is still a very aggressive schedule.

The committee unanimously agreed that the critical path has been identified in all subsystems. It should be noted that the Committee did not examine the proposed Critical Decision dates listed in Table 2.

In summary, the Committee concludes that the revised plan for BTeV construction has a much higher probability of success for completion than the plan presented at the April CD-1 review, and, therefore, finds the BTeV construction project ready for CD-1.

Appendix A

Construction "Need by", "Ready by" dates and float by subtask. In the staged column, we indicate NA if the device is installed before the 2009 shutdown, No if not staged, Yes if staged. The number in parentheses indicates whether it is needed for the run starting in 2009 (staged detector 1) or 2010 (the full, stage 2 detector).

Subtask	"Ready by"	"Needed by"	Float (working days)	Staged
Magnet, Toroid (1.1)	Jul. '06	Feb. '07	145	NA
Pixel Detector (1.2)	Sep. '08	Aug. '09	250	No(1)
RICH Vessel (1.3)	Oct. '07	Sep. '08	202	NA
RICH MaPMT	Jun. '08	Oct. '09	235	Yes(1)
RICH Liquid Circulation System	Jul. '09	May '10	197	Yes (2)
50% Crystals Loaded	Apr. '08	Sep. '09	229	Yes(1)
100% Crystals delivered	Sep.'09	Aug. '10	191	Yes(2)
Muon Station 2/3 (1.5)	Sep. '07	Aug. '09	474	Yes(1)
Muon Station 1	Sep. '08	Aug. '10	475	Yes(2)
Muon Gas System	Mar. '07	Aug. '09	608	Yes(1)
Straw Station 1,2,5,6,7 (1.6)	Oct. '08	Aug. '09	218	Yes(1)
Straw Station 3,4	May '08	Jul. '10	540	Yes(2)
Microstrip Tracker (1.7)	Dec. '08	Aug. '09	186	Yes(1,2)
50% of Trigger (1.8)	Feb '09	Oct. '09	218	Yes(1)
100% of Trigger	Sep. '09	Aug. '10	226	Yes(2)
50% of Data Acquisition (1.9)	Sep. '08	Aug. '09	220	Yes(1)
100% of Data Acquisition	Mar. '09	Jul. '10	310	Yes(2)
C0 IR Quads(2.0)	Dec. '08		368	No(1)
C0 IR Spools	Jan. '09		273	No(1)
C0 Assembly Area (3.0)	Dec. '05	Jul. '06	157	NA

Proposed Tier 1 Milestones for the BTeV Project.

No.	Milestone	Internal Date	Formal Date
1.1	Purchase Order awarded for superconducting wire	Jan. '05	Jul. '05
1.2	Beneficial occupancy of lower level and upper staging area of C0	Dec. '05	Jul.'06
1.3	Vertex Magnet assembled and tested at BTeV operating current	Aug. '06	Feb. '07
1.4	PO awarded for production pixel hybridization	Apr. '06	Oct. '06
1.5	50% of PWO crystals delivered and accepted	Jul. '08	Apr. '09
1.6	Pixel System assembled and tested at SiDet, ready to ship to C0	Sep. '08	Jul. '09
1.7	IR Components that will be installed in tunnel are complete and tested	Sep. '08	Oct. '09
1.8	Detector complete (stage 2) and ready for commissioning with beam	Oct. '10	Apr. '11

Appendix B

Cost Profile vs. Budget Authority in Actual Year dollars vs. Fiscal Year. Included are construction (equipment), R&D, operations (IR spares) and contingency

Cost Profile - M$ AY	FY05	FY06	FY07	FY08	FY09/10	
Equipment Base Estimate	6.75	33.5	38.22	35.23	20.51	134.21
Contingency	2.2	12	13.33	12.37	10.09	49.99
Total Equipment	8.95	45.5	51.55	47.6	30.6	184.2
IR Spares	1.5	0	1.7	1.8	1.7	6.7
IR Spares Contingency	0.6	0	0.5	0.7	0.7	2.5
R&D	6.75	2.2	0	0	0	8.95
R&D Contingency	2.32	0.6	0	0	0	2.92
Total BTeV Costs	20.12	48.3	53.75	50.1	33	205.27
Availability of Funds - M$ AY						
R&D DOE	4.24	2.2	0	0	0	6.44
OP DOE	2.1	0	2.2	2.3	2.4	9
MIE DOE	6.75	39	49	49.4	42.5	186.65
Total DOE	13.09	41.2	51.2	51.7	44.9	202.09
Univ Forward Funding	5.5	2	0	0	-7.5	0
INFN	0.75	1.73	1.88	3	0.15	7.51
NSF	0	0	0	0	0	0
Total Anticiapted BA	19.34	44.93	53.08	54.7	37.55	209.6
Integrated Total BTeV Base Costs	15	50.7	90.62	127.65	149.86	
Integrated Total BTeV BA	19.34	64.27	117.35	172.05	209.6	

BTeV Installation (WBS 1.1 and 1.10)

Referee response to "Follow-up Report on the Schedule for the BteV Project"

Comments (wbs 1.1)

1) The schedule for the magnets and the beam pipes looks reasonable. While it is essential that most of this work be finished before the '09 shutdown, there should not be any major problems in meeting this milestone.

Comments (wbs 1.10)

1) The changes in the schedule and budget are clearly a good move. Splitting the installation into two periods allows considerable flexibility in meeting the necessary milestones. Even if some schedule slippage occurs, it should still be possible to make the Dec '09 start of operations, albeit with somewhat fewer of the detector elements.

2) The addition of 2.1M$ in labor (much of it in contingency) allows the possibility of adding additional manpower and shifts to keep on schedule.

3) The methodology of setting milestones for "ready by" and "needed by" should enable BTeV to spot schedule variances early enough to correct them.

4) Both logistics and safety may have considerable impact on the number of people allowed in the installation area. While it is clear this will be difficult to coordinate, it should be looked at carefully. Most installation estimates assume a "green field" operation, but BTeV will be moving heavy equipment and crates in a very confined area which will cause delays. The installation group should review carefully the subsystem estimates for installation time to ensure there is no double counting in either resources or space.

Conclusions

1) The revised schedule and budget is a significant improvement. However, it is still a very aggressive schedule and, if it is to be successful, it will need to be implemented with great skill and perseverance.

BTeV Pixel (WBS 1.2) and Silicon Strip Detector (WBS 1.7)

WBS 1.2 Pixel Detector
The revised pixel schedule now has about one year of float and we judge it to be achievable. The critical path has been identified.

The BTeV group presented a schedule at the CD-1 review that was significantly limited by funding in the first two years of the project. The revised schedule partly reduces this constraint but remains challenging in mid-to-late 2005. At the CD-1 review we developed milestones for a schedule that was only technically limited. We compare these with some of the current (revised) milestones below.

Milestone	BTeV Current Date	Technically Limited Committee Estimate
PO for production sensors	September 2005	February 2005
PO for production readout chips	October 2005	August 2005
PO for detector hybridization	February 2006	February 2006
Start of pixel station assembly	March 2007	November 2006
Pixel modules completed	November 2007	February 2008

Apart from the first major procurement, our estimate of a schedule (technically limited) compares reasonably well with the revised BTeV milestones.

BTev should make every effort to remain on schedule, or advance the critical component procurements of sensors and integrated circuits (chips) in 2005. This may allow them to gain a few more months of float.

BTeV has chosen to not descope or stage the pixel detector for valid physics-performance reasons. However, we note that should major unforeseen schedule problems develop by late 2006, it would still be possible to descope part of the detector and remain on schedule.

In summary, we judge that the BTeV group has done an excellent job of developing an achievable schedule and of responding to comments from the review committee.

WBS 1.7 Silicon Strip Detector
The silicon strip tracking detector was found to be in good shape at the CD-1 review. The positive news about INFN funding makes the schedule for the silicon strip tracker even more robust.

RICH Detector (WBS 1.3)

We have read the planned changes to the RICH detector. In our original report, we were satisfied that the schedule outlined by the proponents was achievable. The new report describes a three step staged assembly procedure. The main goal is to have the Gas RICH detector ready for data taking in 2009. The liquid radiator and the recirculation system and some of the PMTs will be staged and installed in 2010.

The PMTs for the liquid RICH were to be installed in four sections. Now they plan to mount only the top array in 2009, because it is difficult to access this region once the expansion chamber is present. The remaining three arrays will be mounted in 2010.

With regard to our recommendations,
we are pleased to see that the proponents are planning to simulate and measure the backgrounds in a system test in 2005.

We would like to remind the RICH group to carefully test the capatability of the C4F8O with the materials in the detector. We are concerned that any flexible material, such as used in the expansion volume, or gaskets, may be reactive. The pollution could coat the mirror. One way to minimize the effects of a contaminated gas is to install a "simple distillation" system that separates out the heavy molecules.

BTeV Electromagnetic Calorimeter (WBS 1.4)

Our 3 recommendations at the last review were:

1. Explore ways to arrive at a schedule with comfortable float (≥6 months) by working with BTeV Management and Installation & Integration
2. Add an Installation Engineer to the project.
3. Add US collaborators

Our schedule concern has been addressed by staging:

- relative to the previous schedule, installation is delayed by 1 year
  - and only assumes 50% of the crystals will be installed
- the region populated is the annular area from R=40 to R=120 cm
- the detector is completed by in-situ installation in the 2010 shutdown at the rate of 100 crystals/day

Prior to assembly, loading crystals is done by 1 FTE of physicists. During the shutdown there is about 1.5 FTE of physicist and technician, and in the 2010 shutdown another 1.5 FTE of physicist and technician for crystal loading. This effort profile seems probably ok, but possibly light.

Our first recommendation, to arrive at a schedule with comfortable float, has been satisfactorily addressed. Our other two concerns may need a bit more work over time: In order to coordinate the activities, figure out how to optimize the loading and make it possible to do in-situ loading, we felt that a dedicated installation and assembly engineer was needed. BTeV's solution is: there won't be an "installation engineer", but engineering will be "added as a shared resource to the project". If sufficient resources are made available then this could be made to work. This should be checked at the next formal review.

Our final concern, adding more US collaborators, BTeV is "working on various possibilities", and it is perhaps too soon to expect results.

Conclusion to the charge:

- Is the proposed schedule reasonable and appropriate in view of the technical tasks and proposed funding profiles?

The staged approach seems realistic. Engineering details, relevant for producing a high-quality calorimeter, should be examined at CD-2, as well as staffing levels.

- Has the critical path been identified?

Yes. The previous critical path, crystal delivery, has been solved by stretching the schedule to complete the calorimeter by two years. The new critical path still includes crystal delivery (as well as gluing PMTs onto the crystals).

In addition to the schedule, we had concerns at the last review that the engineering and assembly manpower had been underestimated. The group felt that additional labor as needed could be obtained from Russian and Chinese groups, in a labor category that would not have significant cost impact. If for whatever reason, that were not the case, then labor costs could go up significantly.

BTeV Muon Systems (WBS 1.5)

The construction schedule of the BteV Muon System remains essentially the same. However the change of the installation schedule from August 2007 to August 2009 provides the needed float. The availability of the front end electronics will, perhaps, be the determining factor for meeting the “ready by” date of July 2007 for the first completed station. In summary the committee believes that the schedule has now sufficient contingency that would assure the system’s availability at installation time.

The cost increased by $412 k because of the inclusion of a full time production engineer following a CD1 review recommendation. The profile remains essentially the same. Acting on another CD1 recommendation the Vanderbilt group has proposed a $1M forward funding which is under consideration by the university’s administration. If successful it will enable earlier start of construction which will further increase the schedule contingency.

BTeV Straw Tracker (WBS 1.6)

Committee report on the proposed follow-up report on schedule

There were several recommendations from the Lehman CD1 review. The main recommendation was to address the schedule problem because of the funding and technical concerns. The straw group addressed the recommendation by proposing to stage some of the chambers (chamber 3 and 4), increase the assembly lines and reconfiguring the testing procedures. With the changes, the float days are ~300 days without staging and ~500 days (for chamber 3 and 4) of float with staging. We believe that the proposed schedule is more realistic. (However it is not clear if the proposed funding profile reflects the new schedule.)

There were also several technical issues raised during the review. They were recommended because these issues had to be settled soon in order to start the production. The straw collaborating agreed to carry out the necessary studies including setting up a work plan.

In conclusion, the new proposed schedule is more realistic and the committee endorses it.

BTeV Trigger (WBS 1.8) and Data Acquisition (WBS 1.9)

WBS 1.8 Trigger System

Schedule:
BTeV has taken steps to address our recommendation concerning schedule. Our recommendation was to "Develop a schedule which (a) completes critical design and validation activities as soon as possible and is ready for production six to nine months in advance of the production start date, and (b) completes production of the trigger and data acquisition systems six to nine months in advance of first collisions." Both parts of the recommendation have been addressed in the new BTeV schedule. Critical design and validation activities will be complete fourteen months in advance of the production start date. Production of the stage 1 (50%) trigger system will be complete eleven months in advance of the "Need by" date for the stage 1 detector, and thirteen months in advance of first collisions.

Although the new BTeV schedule was not examined in detail, the proposed schedule is reasonable and appropriate in view of the technical tasks and proposed funding profiles. The detailed project schedule should be examined at the CD-2 review, planned for the first quarter of FY05.

Reviewers at the May 27-28, 2004 Director's Review of the BTeV schedule commented "If more float can be earned by forward funding it should be aggressively pursued as 1.8 is near the critical path." This advice should be followed.

Commissioning the trigger system will involve tasks that can be accomplished without beam and of tasks that will require the beam provided by early running. The time period for commissioning the trigger system allowed by the overall BTeV schedule is not adequate to ensure efficient operation throughout the first physics run. Despite prudent plans for installation of as many trigger components as possible before the "Need by" date and for significant pre-commissioning activities that will facilitate the actual commissioning, the two months between the "Need by" date in October 2009 and the start of the physics run in December 2009 is not adequate to complete tasks that can be accomplished without beam. (Note that commissioning is not explicitly included in the BTeV project schedule because formally it is not part of the BTeV project.)

In summary, schedule recommendations of the CD-1 review have been addressed in a satisfactory fashion. The overall schedule for the BTeV project should provide adequate time to commission the trigger system.

Cost:
It was recommended to "Re-evaluate the basis of estimate of the FPGA costs to allow for uncertainty in the de-escalation profile." BTeV plans a new evaluation by mid-July 2004.

Manpower:
It was recommended to "Quickly identify and apply new individuals and groups to provide the physicist effort called for by the WBS." BTeV has taken steps to identify new individuals and groups to provide this effort. These steps should be continued, especially in the area of trigger software.

WBS 1.9 Data Readout and Control (Data Acquisition) System

Schedule:
It was recommended to "Develop a schedule which (a) completes critical design and validation activities as soon as possible and is ready for production six to nine months in advance of the production start date, and (b) completes production of the trigger and data acquisition systems six to nine months in advance of first collisions." The second part of this recommendation has been fully addressed in the new BTeV schedule. Production of the stage 1 (50%) data acquisition system will be complete eleven months in advance of the "Need by" date for the stage 1 detector, and fifteen months in advance of first collisions. The first part of the recommendation, which was intended to mitigate schedule risk imposed by technical risk, has also been adequately addressed through the addition of float in the schedule and through the reuse of design work from other projects for BTeV designs. The schedule, which already included an appropriate number of design iterations, now includes a total of four to six months of float prior to the production start date, as well as eleven months after production completion. It also presumes the continuation of closely related design activities by BTeV collaborators for TeVatron instrumentation and for the BTeV Pixel/Silicon subproject. These activities further mitigate schedule risk.

It also presumes the continuation of closely related design activities by BTeV collaborators for TeVatron instrumentation and for the BTeV Pixel/Silicon subproject.

Although the new BTeV schedule was not examined in detail, the proposed schedule is reasonable in view of the technical tasks and proposed funding profiles. The detailed project schedule should be examined at the CD-2 review, planned for the first quarter of FY05.

Commissioning the data acquisition and control system will primarily involve tasks that can be accomplished without beam. The time period for commissioning these systems allowed by the overall BTeV schedule is not adequate to ensure efficient operation throughout the first physics run. Despite prudent plans for installation of as many data acquisition components as possible before the "Need by" date and for significant pre-commissioning activities that will facilitate the actual commissioning, the four months between the "Need by" date in August 2009 and the start of the physics run in December 2009 is not adequate to complete tasks that can be accomplished without beam, particularly considering the arrival of some detector components late in the 2009 installation period. (Note that commissioning is not explicitly included in the BTeV project schedule because formally it is not part of the BTeV project.)

In summary, schedule recommendations of the CD-1 review have been addressed in a satisfactory fashion. The overall schedule for the BTeV project should provide adequate time to commission the trigger system.

Cost:
It was recommended to "Re-evaluate the basis of estimate of the FPGA costs to allow for uncertainty in the de-escalation profile." Although BTeV has adopted a new approach to estimating the de-escalation profile, the uncertainty in the profile is still not taken into account in the BTeV cost estimate. This uncertainty should be more fully accounted for in the contingency estimate.

Manpower:
It was recommended to “Quickly identify and apply new individuals and groups to provide the physicist effort called for by the WBS.” BTeV has re-assigned some activities from physicists to engineering categories, thus diminishing the shortfall in physicist effort. They state that they expect additional university contributions to physicist effort; however, they do not state that they have taken steps to identify that effort yet. Steps should be taken in a timely fashion.

BTeV C0 Interaction Region (WBS 2.0)

Findings

The C0 IR installation is not staged. It will be installed in a single shutdown in 2009.

The critical path item is 14.3.2 (spool pieces) followed by 14.3.1 (quadrupoles). The schedule float has increased from almost zero to 12 months. The quadrupoles have 17 months of float. Additional float for the spool pieces was generated by:

- A 2 month delay in the 2009 shutdown
- Delay in the installation of the last non-spare spool
- Reordering of the spool production so spares are last
- Shortening procurement of spool by 7 months. This is done by adding additional designs and engineers up front. Additional spool vendors have been identified since the last review.

Time was added to reflect the most recent experience with the LHC DFBX feedboxes.

Vendors have been identified for the corrector magnets that are part of the spool assembly. These had been previously been identified as the critical path. Due to recent discussions with 4 other labs, the procurement for the correctors has been shortened by 4 months (to 7 months) resulting in an additional 3 months of float.

Additional float in the quadrupole schedule was obtained by reordering the production so that the last 5 quadrupoles are spares. The quadrupoles now have a total of 17 months of float.

Comments

Recommendations from the May Director's Review of the BTeV Schedule have resulted in additional schedule contingency for the critical path and several near-critical path tasks. The schedule for the spool pieces has been made more reliable due to the recent input from the LHC DFBX procurement.

There are now several options for the HTS leads, adding schedule contingency and reducing cost. The schedule for the corrector magnets can be protected by exercising a more expensive but reliable option for procurement.

Several modifications to the fabrication and procurement plan have resulted in additional schedule contingency. The proposed schedule seems reasonable and appropriate given the additional float and the recent experience of the Fermilab Technical Division. Testing is a potential schedule risk and should be planned carefully, with an aggressive start so unforeseen problems can be corrected.

Recommendations

Exercise higher cost option to procure correctors to reduce schedule risk

BTeV CO Outfitting (WBS 3.0)

The C0 Outfitting schedule, which had been found to be reasonable in the CD-1 review, remains unchanged. Additional advanced conceptual design, which leads to a slightly lower estimated cost and headcount, will lessen the schedule risk associated with the prompt placement of the large Phase 1 procurement. The new schedule methodology will allow better tracking of this sub-project's critical path.

BTeV Cost/Schedule and Funding/Management

Management Subcommittee (Aronson, Makdisi, Mecking, Miller, Paulos)
Cost, Schedule & Funding Subcommittee (Reichanadter, Tkaczyk)

General Findings

The BTeV team has put together a credible plan for meeting the overall goals of the project. They have certainly taken seriously the Committee recommendations and have developed what looks like a very sensible plan.

The BTeV schedule has been improved by; (1) a two-phased staged installation schedule adding approximately six months to the unstaged plan, (2) improved funding profile, (3) rescheduling of project activities with respect to the critical path, and (4) explicitly identifying schedule float that was previously hidden. The improved schedule, with solid physics capability at each stage and the roughly doubled installation time are all very much in the right direction, with greatly increased schedule float in all areas. The early part of the funding profile has further eased the schedule and each year appears to have 25% or more contingency above the base cost estimates.

The BTeV management team has adopted "Ready By" and "Need By" dates for its primary deliverables, which provides greater visibility into the critical schedule float periods of the BTeV project. The overall project's critical path for the Stage 1 phase has been identified as running through the Pixel Detector and Interaction Region. Other Stage 1 critical activities are the 100% delivery of the lead tungstate crystals, and 50% delivery of the data acquisition and trigger components. All areas show reasonable period of float and conservative schedule assumptions (i.e., single shift operations) thus providing a realistic schedule.

Overall, the revised BTeV plan appears to have a much higher probability of success than the plan presented at the April CD-1 review. Given that BTeV management is in the critical project startup phase, this is a major step in providing a credible plan to go forward. The BTeV team is to be congratulated on their creative, substantive and rapid turnaround efforts.

Specific Comments

1. As the INFN contribution is a mix of real funds and "in-kind" contributions and assuming some flexibility with the Syracuse forwarded funds, BTeV management should consider optimizing its use of available funding in the early years to address the major schedule risks on the BTeV project.

2. The BTeV project uses a variety of different fund-types over the life of the construction project (R&D, Oper, MIE, etc.). In anticipation of CD-2, care should be exercised to match the appropriate fund-type with the specific type of work/effort being performed.

3. The calorimeter schedule risk is mitigated by having two production sources. Is there a credible contingency plan if CMS does not manage to increase the calorimeter module production capacity?

4. The first staging phase appears to be well supported in terms of schedule and reasonable funds. However, there is some concern that second stage funds could be misspent on the first stage. A "Base Cost + Contingency" benchmark between the first and second stages would help to ensure that the funds are not depleted in the first stage of the BTeV project.

5. Regarding physics comparisons with LHCb: While not directly within our charge, we did this subject by recommending that any new schedule incorporate competitive physics on a timely basis. In the opinion of this committee, BTeV appears to have argued successfully that they will be quite competitive.

6. There is some concern that the brief period of physics between the two installation stages is not realistic, and that this period could be used more effectively as a commissioning or engineering run of the BTeV detector.

7. On p. 30 section 4.2 on schedule methodology, the Follow-up Report says "the actual time for installation is only 30 weeks long for both stages combined." This refers to the shutdowns in 2009 and 2010. However, by then it would appear that BTeV's needs would dictate the schedule. Why aren't these shutdowns as long as needed by BTeV (modulo the constraint of timely physics output)?

8. What follows is a number of detailed questions on the revised schedule. These are provided as pointers to possible disconnects or legacy items from the previous schedule that we expect will be addressed in the normal course of tuning the new schedule. The references are to the BTeV Follow-up report:
    a. There appears to be a tight schedule in the construction and equipping of the C0 Assembly building vs. the vertex magnet / toroid assembly, installation and testing: On p. 53, fig. 22 the magnet measurement is June 06 while table 35 p. 137 indicates Mechanical and Electrical systems (required for magnet measurements) completed in mid 07. Similarly one would expect a relatively clean room arena for assembly of the RICH detector, which we did not see in the plans.
    b. P. 33 on C0 2005 shutdown schedule (remove magnets): Are these compensated elsewhere, so that the Tevatron can continue to run?
    c. P. 34 2007 shutdown "install 10% pixel:" This seems like a legacy item from the old installation plan. This time could be allotted to installing the vertex magnet if not ready in the 2006 shutdown.
    d. Task completion vs table on page 44.
        i. 1.1 Magnet: Ready by Jul 06; Needed By Feb 07 (FY07), yet the funding profile extends to FY 08 and 09? Is this because of beam pipes and manpower that are completed later?
        ii. 1.5 Muon systems: completed well before FY09 yet they are staged. Does funding profile drive the staging?
        iii. 1.7 Microstrip tracker: staged yet there is very little money ($220k) in FY 09. Is this also driven by profile rather time?
        iv. 2.0 C0 IR Quads and Spools: funding stretches into FY 10 even though they plan to be running before then.

v. 3.0 Assembly Area: ready by Dec 05 (FY06) needed by July 06 (FY06) yet FY07 shows 2.6 M to go? Does this refer to beneficial occupancy after which it will be equipped for assembly work? If so can the magnet assembly proceed accordingly (ready July 06?)
vi. Table 10: Need by for North Toroid is Feb 08 when Table 4 for all 1.1 indicates Need by Feb 07.

e. The current DOE Critical Decision (CD) milestones appear widely spaced with CD-3b in 3Q-05 and CD-4 in 3Q-11. Consider a CD-4a milestone to closeout the first stage of the BTeV and a CD-4b milestone for the second phase.